DESCRIPTION

OF

THE THEORY AND PROPERTIES

OF

INCLINED PLANE WHEELS,

&c. &c.

A

DESCRIPTION

OF THE

THEORY AND PROPERTIES

OF

INCLINED PLANE WHEELS,

BY WHICH

POWER AND VELOCITY WILL BE INCREASED,

AND

FRICTION DIMINISHED,

IN ANY MACHINERY INTO WHICH THEY CAN BE INTRODUCED;

AND BY THIS MEANS

The Effect of such Machinery will be greatly increased.

BY THE INVENTOR

T. SHELDRAKE,

LONDON:

PREFACE.

———

THE following pages are submitted to the public, in hopes that they will be found to open a way to important improvements in the great machinery of the country.

The Author was engaged upon a particular subject in Mechanics, and found that he was in want of powers which the known machinery did not supply : he made experiments, and at length succeeded in obtaining the powers he wanted. When the object of his researches is laid before the public, it will, he has no doubt, be allowed to be important, and, he has reason to believe, it will then be seen that his success has been compleat.

But,

But, as in the pursuit of a particular in-
dividual object, he discovered improvements
which, he had reason to believe, might be high-
ly advantageous, if introduced into machinery
in general, he thought it right that every one
to whom the discovery would be advantageous,
should have the liberty of using it in that way
which would most effectually benefit his own
works; he thought it right, too, that the in-
ventor should derive adequate advantage from
his own discovery : to secure this double advan-
tage he has procured a patent for his invention,
and now submits it to the public at large that
every one who chuses to do so, may take the
benefit of it.

Engineers, and others, who are engaged in
the superior machinery of the country, will,
after having perused these papers, be able to
determine how far the invention which is therein
described can be adopted, with advantage, into
their works ; they will either project the parti-
cular combinations which they may chuse to
                                        adopt,

*adopt, in which case they will, on application
to the patentee, be licensed to introduce them;
or, if they should prefer it, on consulting
with them, he will design for them, and su-
perintend the execution of such wheels as may
be thought most conducive to the objects which
they may have in view.*

*The manufacturers of machinery of any kind,
and in any part of the kingdom, who may judge
that the introduction of these wheels into their
works will be advantageous, will, on applica-
tion to the patentee, be supplied with whatever
they want, designed by himself, and executed in
the best manner at manufactories in London,
that will be under his immediate direction.*

*It has already been said, that he was led to
this discovery by making experiments upon a
particular subject in mechanics; it would be
useless to enter into the particulars of that
subject at present, but it is sufficient to say,
that it will, as soon as circumstances can admit,
be laid before the public; when he presumes*

to

to hope, it will be found that, independent of whatever use others may chuse to make of the opportunity now offered to adopt this invention, it is, in its consequences, likely to prove highly advantageous to several departments of trade and manufactures.

No. 50, Strand, April 30, 1811.
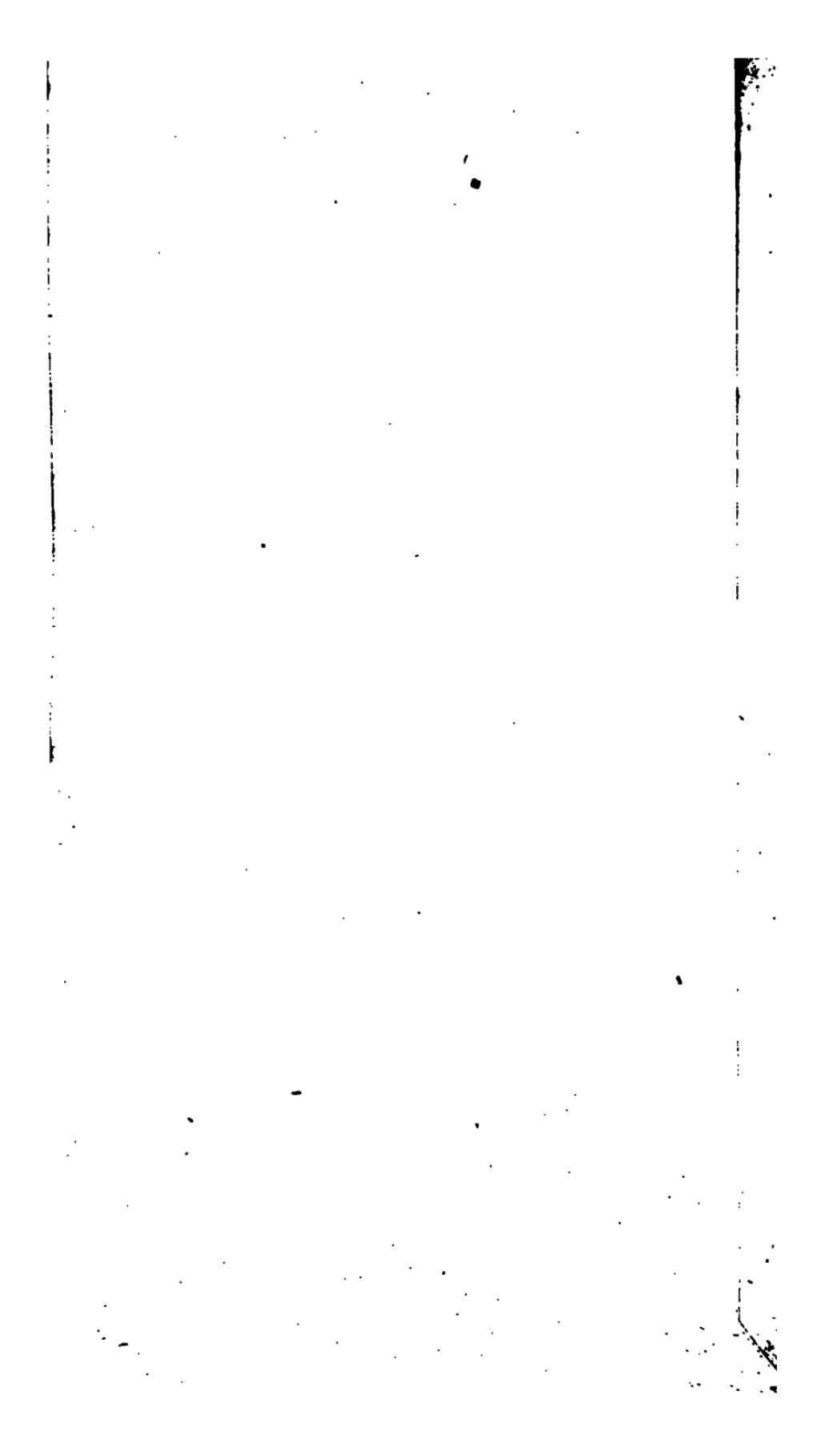
Fig 2.

Fig 1.

E A

D

Fig 7.

B

F

C
C

Fig 8.

Fig 9.

Fig. 10.

A
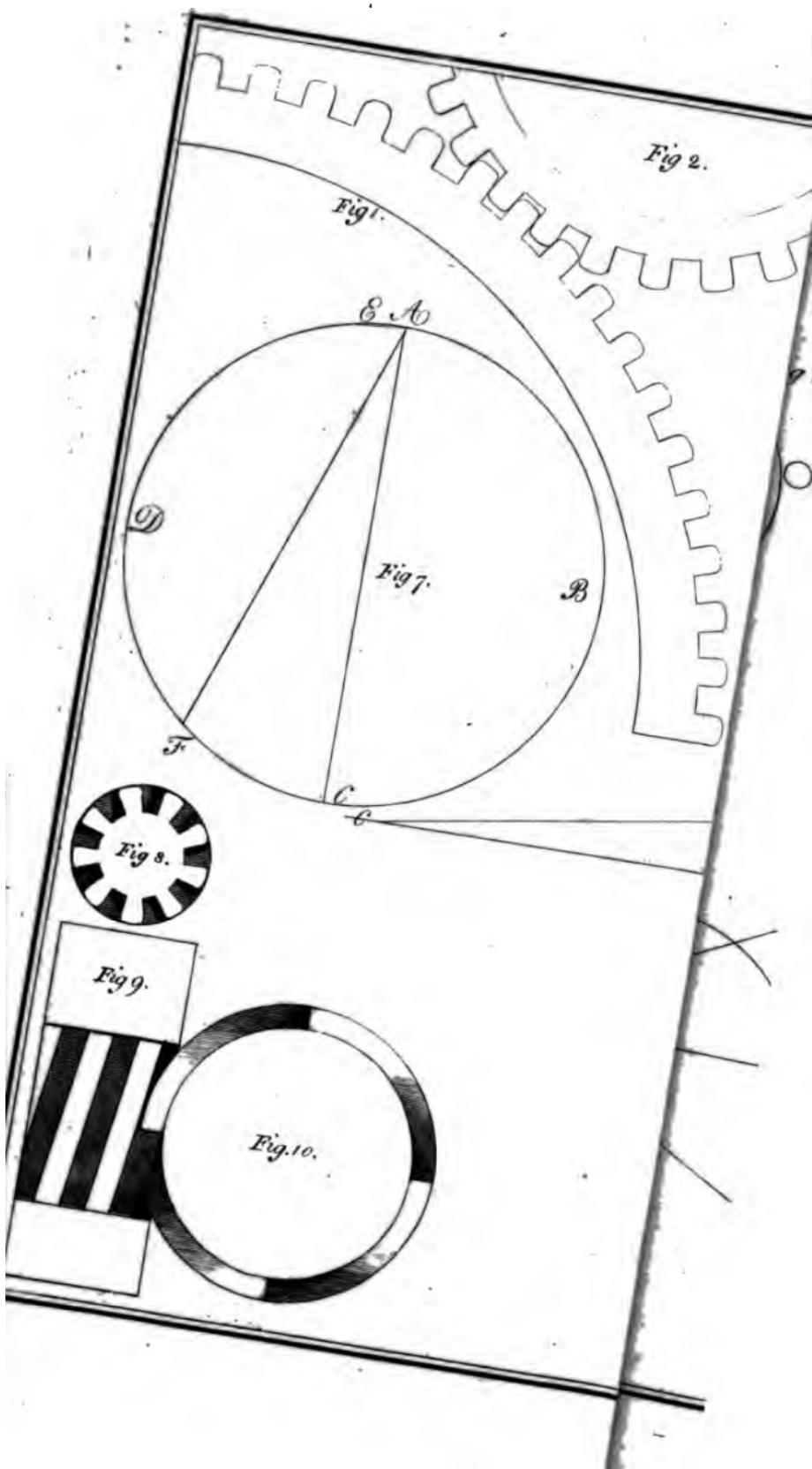
DESCRIPTION

OF THE

THEORY AND PROPERTIES

OF THE

INCLINED PLANE WHEELS,

&c. &c.

———

THE immense advantages which every depart-
ment of the trade and manufactures of the
British Isles has derived from the modern im-
provements in machinery, have created a dispo-
sition to look, with a favourable eye, upon every
attempt to carry all mechanical engines still
nearer to perfection, and will render any apology
for publishing this tract unnecessary, provided
the invention which it is intended to describe,
should be really calculated to promote objects, of
such great national importance.

B   The

The invention consists of two wheels, one of which may be called the active, the other the passive wheel; because, when the former is acted upon by any extraneous power, it *produces* power in itself, and communicates that power, as well as motion, to the passive wheel, which is moved by it; and thus the whole of its power and velocity are communicated to any machinery, of which these wheels form a part.

To understand the construction and power of these wheels, it will be necessary to refer to the figures which accompany this description. *Fig.* 1, *Plate* 1, represents a portion of a common toothed wheel, which is turned by *Fig.* 2, a wheel of the same kind, but of smaller diameter. *Fig.* 3, is a portion of the face of the same wheel, laid down strait to shew its breadth, and the diameter and number of its teeth.

If we calculate or measure the surface of these teeth, round the whole circumference of the wheel, we shall find, that the measure of this circumference will be nearly three times as much

as

as the actual circumference of the wheel would be, if its surface was quite plane ; consequently, whatever power is employed to turn it once round, must traverse three times as much space as would be necessary to effect that revolution, and, of course would occupy three times as much time as would be necessary to effect that revolution, if the surface of the wheel was quite plane.

But other circumstances must be taken into consideration. Upon examining the manner in which the teeth of the wheels, 1 and 2, are locked together, it will be evident, that three teeth of the passive wheel oppose, at the same time, almost the whole of their diameter to the action of the moving power, which must overcome them before it can move one tooth ; and then another immediately takes its place, so that to whatever extent the revolutions of these wheels may be carried, it uniformly requires that the resistance of almost three teeth should be overcome, before one tooth can be moved. Supposing the work to be accurately made, each tooth of the

moving

moving power must bear *upon one side, and upon the top of the* opposing tooth, for the whole breadth of the wheel's face, and for the length of almost three teeth at one time, during the whole revolution of the wheel : hence it is evident, that whatever quantity of friction is created by the motion of these wheels, during the whole time they are at work, is thrown upon a portion of their surface equal to twice their circumference, and their whole breadth. It is well known, that in all powerful machinery, much of the time and the power employed is occupied in overcoming the friction, and the effect of the machine is diminished in proportion to the friction of its component parts.

This waste of power and time is diminished, as much as in the nature of things possible, by substituting the wheels which are now to be described, for those which have been generally used in all machinery, that has been moved by common wheel-work.

One peculiarity of the invention consists in

cutting

cutting the teeth of the wheels, not across the face, in lines parallel to their axes, but in diago·nal lines, diverging from the parallel line on one side of the wheel's face, to the parallel line on the other side, and ranging to any length, according to the angle which I wish to give to the tooth. This may be at any angle, from five degrees of an inclined plane to eighty-five; but, for the purposes of this demonstration, I shall confine myself to the angle of eighty degrees, which is the greatest extent of motion that has yet been given to any wheels that I have executed.

Fig. 4 and Fig. 5, represent portions of wheels, the same size as those which are represented by Fig$^{res.}$ 1 and 2, Fig. 4 and Fig. 5, have their teeth of the same diameter as the teeth of Fig$^{res.}$ 1 and 2; but those teeth in Fig$^{res.}$ 4 and 5 are cut upon a diagonal line, whose angle is equal to an inclined plane of eighty degrees, from a line drawn parallel to the axis of the wheel. By this means, one diagonal tooth and its space go as far upon the face of the wheel, as fourteen of the parallel teeth and their spaces.

Place

Place one foot of the compasses on the
diagonal line of the tooth and space; *Fig*. 6, which
represents a portion of the face of the wheel, and
measure its length; then turn it to the perpen-
dicular line, and it will appear, that the diagonal
is but one-seventeenth part longer than the actual
circumference of a similar portion of the wheel,
supposing its face to be perfectly smooth : to this
add two diameters of the square of the tooth, to
account for the increased surface occasioned by its
height, and it will appear, that the increased space
which the wheel must travel over, in consequence
of this form of the teeth, is but about one-fifteenth
of its actual circumference ; therefore, by cutting
the teeth upon this diagonal, instead of the pa-
rallel line, one circumference, and fourteen-fif-
teenths of the friction and motion of the wheel
will be saved in every revolution; and, of course,
so much will be added to the velocity and ex-
ecution of the machine, without any actual in-
crease of its moving power.

But other circumstances are to be consider-
ed, which will render the difference of velocity in
the

the two systems more considerable. It has already
been shewn, that in the revolution of a common
wheel, the friction is laid upon two diameters
of three teeth, and the almost whole breadth
of its face, uniformly during its whole-evolution;
the surface thus acted upon by friction is six
diameters of a tooth for its whole breadth; but,
upon inspecting the action of the diagonal teeth,
it will be found, that they never come in contact
with each other, upon more than one point on
each side, at the same time, and these points are
continually and regularly shifting during the
motion of the wheel; it is impossible that there
should, in any case, be any accumulation of
friction upon an increased surface, and therefore
it is evident, that all the friction which can be
exerted upon one diagonal tooth, which bears the
whole power of the machine during the course of
its movement, under the direct impulse of the
moving power, is but equal to a sixth part of the
friction of the common toothed wheel; and if
it is farther considered, that the diagonal tooth
which

which bears this quantity of friction, will range fourteen times as far with it as the parallel tooth will ; it seems evident, that the friction which is exerted upon any given portion of a diagonal toothed wheel, will amount to little more than a fortieth part of the friction that must be sustained by the same portion of a common wheel, while it is employed to do the same work.

If, however, it should be found, that this estimate is exaggerated in favour of the diagonal toothed wheel, there is abundant reason to believe, that its power is not over-rated, in stating the following to be the law by which their action is regulated ; *viz.* that whatever power will completely turn a parallel tooth in a given time, will, *in the same time,* drive a tooth, the diameter of whose square is the same, upon any length of an inclined plane, or diagonal line, to which it may extend, PROVIDED *that all other circumstances are equal.* This being the law, it is evident that equal quantities of any two diagonal toothed wheels that can move each other, while their

axes

axes are parallel, will perform that motion in the
same time, but the relative number of evolutions,
if performed by any two wheels, will be as the
difference of their diameter ; and the number
of revolutions performed by any two of these
wheels, when compared to the revolutions per-
formed by parallel toothed wheels of the same
dimensions, will be as fourteen to one, if all
other circumstances are equal.

These papers were submitted to the judg-
ment of a scientific friend, that he might detect
any error, fallacy, or mis-statements, if any such
existed in them.   Upon the point under discus-
sion he observed, " I have no doubt of the fact :
" indeed, writing, as you do, with the machine
" before you, it is impossible that you should mis-
" take the fact, though it may be difficult to frame
" a mathematical demonstration that will account
" for it: perhaps the following may be satisfactory.
" Let A. B. C. D., fig. 7. represent the
" circumference of a circle, or wheel : set off
" any distance from A. to E., to represent the

c   " space

" space a parallel tooth would pass over in a
" given time, from A. to F.: set off fourteen
" times the assumed space, A. E., and draw the
" chords, A. E., A. F. Now, by a well-known
" law of mechanics, a heavy body would fall
" down the inclined plane, A. E., in the same
" time that it would fall down the inclined
" plane A. F., or any other chord which could
" be drawn, and will always be equal to the
" time taken in falling perpendicularly down
" the diameter of the circle.

 " When the times and velocities are un-
" equal, the spaces are in the compound ratio
" of the times and velocities ; but when the
" times are equal, the velocities are as the spa-
" ces. Now, as the spaces are as fourteen to
" one, the times are equal ; by assumption, the
" velocity of a body, in falling from A. to F.,
" will be fourteen times greater than in falling
" from A. to E.

 " This being true, with regard to a heavy
" body falling down the inclined planes, the
          " same

" same results, it appears, must be produced by
" the action of the inclined plane wheels."

If this demonstration should be satisfactory,
it will prove, that the velocity of any two of these
wheels, will be as fourteen to one, to the velocity
of two parallel toothed wheels of the same di-
mensions ; consequently, if these wheels are
introduced into any existing machine, instead of
the parallel toothed wheels of equal dimensions,
the power of that machinery will be increased,
in the proportion of fourteen to one, provided
all other circumstances remain equal.

The next peculiarity of the invention is
that which is called the active wheel, because,
when it is acted upon by any extraneous power,
it generates power and velocity by its own energy,
and communicates them, by the passive wheel,
to any machinery to which it is applied, or
into which it is introduced. The introduction
of this wheel will establish a law that is new
to practical mechanics, and directly militates
against that law, which is generally adopted,

and

and is, by many, believed to be *universally
true, viz.* that in constructing compound ma-
chinery, " so much as is gained in power, is
lost in time." The law to be established by
this active wheel is, *that the velocity increases
as the power, and the friction diminishes as the
time.*

Being in search of a power that should com-
bine greater velocity, with greater power than
were known to exist in any machinery that I had
seen, or than was described in any book that I
could find, it occurred to me to construct two
wheels, with their teeth in the direction of in-
clined planes, so regulated, that they should
turn each other, when their axes were placed at
right angles, instead of parallel lines, and I
found myself in possession of the power I want-
ed. The discovery was empirical, but its phe-
nomena were so striking, that they irresistibly
impelled me to attempt, at least, to investigate the
laws upon which those phenomena depended. I
shall now explain so much of those laws, as I
have

have been able to ascertain, though I am aware
that able men may carry the discovery to a point,
far beyond any thing that I have any idea of,
and shall point out some of the uses to which
the discovery may be applied; leaving the ex-
tension of it to those, who have more know-
ledge, and more opportunities of applying it,
than I shall ever have in my power.

I have in my possession two wheels; the
diameter of one of which is three inches, of the
other something more than seven inches: by
making one revolution of the three inch wheel,
two complete revolutions and one-fourth will be
produced, of that which measures seven inches,
or, in other words, the circular movement
of a body, whose superfice measures nine inches,
will complete the circular movement of another
body, whose superficial measurement is more
than forty-seven inches. If this declaration had
been found in the papers left by a dead man,
without any clue to explain it, it would be con-
cluded, that he wrote it in a paroxysm of deli-
rium;

rium ; if it should be found in some old printed book, the author would be characterized, as it was once fashionable to describe the Marquis of Worcester, as a weak-minded fanciful projector ; but as the wheels are in a state to be produced, I shall have credit for the fact, and be permitted to explain so much of the laws upon which it depends, as I have been able to ascertain. When I have so done, I hope the subject will be taken up by some one, who is better qualified to do it justice; and am susceptible of no higher gratification, than can be derived from seeing it carried to the highest degree of perfection, to which great talents may carry it.

These wheels are to be considered as to their power, their velocity, and to both united. At present it will be attempted to explain the manner in which they produce the peculiar degree of velocity which they will be found to communicate.

Fig. 8, represents the side of a wheel, whose circumference contains nine teeth. *Fig.* 9, shews

shews one side of the face of the same wheel, its
teeth cut on a plane of ten degrees from the
face of the wheel, which stands in a vertical po-
sition, and which is therefore the same as eighty
degrees from the horizon. *Fig.* 10, shews the
side of a wheel, whose axis is laid horizontally,
and at right angles with that of *Fig.* 9. Upon
this wheel are cut four teeth, each of which is
cut at the same angle *around* its axis, as will
correspond with those teeth which are cut lon-
gitudinally upon the vertical wheel. The conse-
quence of this opposition to each other is, that
by turning upon its vertical axis that wheel *Fig.*
9, which I have called the *active* wheel, in
making one revolution it passes over the space
that is equal to nine diameters of a tooth ; the
passive or horizontal wheel, having its axis at
right angles with the vertical, has the length
of its teeth at right angles with the diameter of
the square of the teeth of the active wheel ;
therefore the horizontal movement of *Fig.* 9, for
a space equal to the diameter of one tooth, drives
the

the horizontal, or passive wheel, for the *length* of one tooth, in the same time, according to the law . which has been already demonstrated, *viz.* " *that whatever power will completely turn a parallel tooth in a given time, will, in the* SAME TIME, *drive a tooth, the diameter of whose square is the same; upon any length of an inclined plane, or diagonal line, to which it may extend,* PROVIDED THAT ALL OTHER CIRCUMSTANCES ARE EQUAL." The horizontal, or passive wheel, having but four teeth, and the vertical nine, it necessarily follows, that the velocity of the passive wheel to that of the active, is as nine to four; *i. e.* as it appears by measuring those wheels upon which these experiments were made, their relative proportions are as nine inches to forty-seven and a quarter.

It may be objected, that this statement is incorrect, because if the number of the teeth were as nine to one, and the proportions of the wheels were to be found by multiplying that number, the product of the circumference would be eighty-one inches. This is a fallacy which is

to

to be explained. The proportions of the dia-
gonal to the parallel teeth, are as fourteen to one.
In laying out the diagonal teeth upon the face of
the wheel, it is necessary that a space equal to the
diameter of its square be left between each pair of
teeth ; if the breadth of the wheel is equal to
three diameters of the square, which is the best
plan to be adopted in laying them down, it will
be found, that the tooth on each side is over-
lapped for almost half its length, by almost half
the length of the tooth before it on one side, and
as much of the length of the tooth behind it on
the other ; for this reason it will be evident, that
to estimate the increase of a wheel, in the pro-
portion of its increased circumference to the
increase of the number of its teeth, it will be
necessary to take half the length of the first
tooth, and add to it as much for every succeeding
tooth, which will give the length of any wheel
according to the number of teeth of which it
consists.

The size of the vertical wheel will, on the

D   contrary,

contrary, increase in exact proportions, according to the increased number of its teeth; for example, if the teeth are half an inch in diameter, and it contains nine teeth, the circumference will be nine inches; if ten teeth, ten inches; and so on, increasing regularly one inch for every tooth: but if the horizontal wheel contains nine teeth, we are to reckon five inches and a quarter for each tooth, as that is half the length of a tooth of the above dimensions, so that the progressive increase of the size of the two wheels, in proportion to the increase of the number of their teeth, will be

$$1 \ldots \ldots 5\tfrac{1}{4}$$
$$2 \ldots \ldots 10\tfrac{1}{2}$$
$$3 \ldots \ldots 15\tfrac{3}{4}$$
$$4 \ldots \ldots 21$$
$$5 \ldots \ldots 26\tfrac{1}{4}$$
$$6 \ldots \ldots 31\tfrac{1}{2}$$
$$7 \ldots \ldots 36\tfrac{3}{4}$$
$$8 \ldots \ldots 42$$
$$9 \ldots \ldots 47\tfrac{1}{4} \text{ &c. &c. ad infinitum.}$$

Hence

Hence it is evident, that, if all other circum-stances remain equal, by adding a diameter of the square of a tooth to the circumference of a vertical wheel, so much is added to its power, and, at the same time, five times and a quarter as much added to the velocity of the horizontal wheel; which seems to demonstrate the truth of that law which has been laid down, that the velocity increases as the power, and, in that particular modification of power which has been adopted for the purposes of this explanation, the increase of velocity is to the increase of power, as five and a quarter to one.

The different proportions of the vertical, to the horizontal wheel, are regulated by certain laws, which differ materially from the laws by which the proportions of common wheels are regulated. But there is no limitation, to the relative proportions of the number of the teeth, in the vertical and horizontal wheels; for example, the vertical wheel, which has been described as containing nine teeth, may be employed to

turn

turn a horizontal wheel, whose number of teeth is
equal, is double, or in any more extended propor-
tion, to whatever extent it may be desirable to ex-
tend it, or may, to any smaller number, even dimi-
nish the number of teeth in the horizontal wheel
as low as one: thus, if the vertical wheel contains
nine teeth, and its circumference is nine inches,
one revolution of it will make one complete revo-
lution of a horizontal wheel, whose number of
teeth are equal to it, and whose circumference is
therefore forty-seven inches and a quarter; or it
will, *in the same time,* perform nine revolutions
of a horizontal wheel which has but one tooth.
The skilful machinist will perceive, that this
facility of varying the proportions of the wheels,
will give him great advantages in modifying the
power and velocity of his machinery, according
to the effect he wishes to produce, and likewise
in the space he chuses to occupy, or to which he
is necessarily confined; for, if one revolution of
the vertical wheel, will produce one revolution of
that horizontal wheel, whose circumference is
forty-seven inches and a quarter, in a given time,
it

it will produce nine revolutions of that wheel,
which contains but one tooth *in the same time;*
thus the effect of the machinery may be the
same, whether it is confined to the space occu-
pied by the vertical and the one-toothed wheel,
or whether it is extended to that space, which
is occupied by that wheel whose circumference is
forty-seven inches and a quarter.

Let us now turn to the vertical or active
wheel. *Fig.* 9, is a wheel placed with its axis
in a vertical position, with its teeth cut on the
angle of a plane, descending eighty degrees from
the zenith to the horizon. These teeth are
locked into those of the horizontal wheel, and it
is turned on its axis, with its face perpendicular
to the horizon, by any power applied to the upper
axis. When this wheel is so moved, the line of
motion of its teeth moves downwards, in the di-
rection of eighty degrees, and drives the corres-
ponding tooth of the horizontal wheel round the
circumference of that wheel, turning it first *from*
itself to an angle of ten degrees downwards,
which is soon turned into a line, plane to the
horizon,

horizon, but in a diagonal direction of ten degrees from a parallel line. In this state it is curled upon the surface of the horizontal wheel, and carried round, till it meets the vertical tooth again. Thus, we see the course by which a vertical plane is turned into a horizontal one, and that effect which has been stated to be the law, by which the action of these wheels is regulated, is produced, *viz. that whatever power will turn a parallel tooth completely in a given time, will, in* THE SAME TIME, *drive a tooth, whose square is the same, upon any length of an inclined plane, or diagonal line, to which it may extend, provided that all other circumstances are equal.* This law will, perhaps, be better explained by the annexed figure 10, which will, likewise, demonstrate some other points that will soon be illustrated.

Suppose two horizontal lines with inclined planes marked upon them, at the respective angles of ten, twenty, thirty, forty, fifty, sixty, seventy, and eighty degrees : change one of these horizontal lines into a perpendicular, let the two series

series of plane lines diverge from the same point, and the order of the planes will be changed, *i. e.* that line which inclined ten degrees to the horizon, will now decline eighty degrees; but their lengths will be the same, and every other angle will be reversed in the same manner. Place a body upon the point where the ends of the planes of eighty and of ten degrees meet : let this body be so constructed, that by one action of the same moving power, it shall divide into two parts, and each be impelled down the plane, which is in the line of its motion : suppose the action of gravity to be out of the question, and both these bodies would arrive at the end of their respective planes at the same moment of time. This is precisely the action of the two wheels; but if the line of the horizontal plane is continued across the perpendicular plane, to the extreme point to which that has descended, it will be seen, that the horizontal extent of the perpendicular plane has been but ten degrees, therefore, although each of the two bodies has moved

to

to the same distance upon its own line, in *the same time*, yet when the motion of both on *the same line* is examined, it is evident, that the quantity of motion in the horizontal, to that in the perpendicular line, has been in the proportion of eight to one. Having thus demonstrated the law by which the motion of these wheels is governed, let us proceed to investigate their power.

If *Fig.* 9, was a cylinder of cast iron, or any other heavy matter, fixed upon a vertical axis, and turned by any power applied to the upper extremity of that axis, when so much power was applied as would overcome the friction of the body upon its axis, it would begin to move, and would acquire velocity of motion, in proportion to the superabundant force which constituted the moving power : but this would be a mere circular motion, without any consequences.

If this cylinder is cut with teeth upon an angle of eighty degrees, as represented by the figure, to correspond with, and lock into, the

wheels

Wheels of the passive wheel, *Fig.* 10, by turning
the axes of *Fig.* 9, the horizontal wheel would
be compelled to move ; the weight of the ver-
tical wheel would constitute a part of the moving
power, to be computed according to the known
law of a heavy body moving down an inclined
plane, and communicate its whole influence
through the passive wheel, to the whole machi-
nery that might be connected with it. The
whole moving power of such machinery would
be compound : the weight of the vertical wheel,
acting by the known law of heavy bodies mov-
ing down inclined planes, would be the existing
power ; the moving power may be called the
extraneous ; the *whole power* would be found
by multiplying the two together : thus (accord-
ing to the nature of the machinery), suppose the
weight of the vertical wheel to be nine pounds,
hundred weights, or tons, and the plane an angle
of eighty degrees, the real moving power would
be eight pounds, hundred weights, or tons, which
multiply by the quantum of the moving force

E   applied,

applied, deduct the friction of the machine, and you will have that power which the machine will bring into action.

The skilful machinist will perceive, that in situations where he requires great power, he may, by adopting these wheels on a large scale, produce an immense power, and at a, compara-; tively, small expence. If the power of a small steam-engine is employed as a moving power, to set in motion a train of machinery of this kind, and of great magnitude, it would produce as much effect as a large steam engine constantly applied, and all the extra expence of fuel for the large engine, and the expence of the larger engine itself, would be saved.

Upon the diminution of friction as the velocity increases, it may be said, that the inclined planes, A. B. and A. C., *Fig.* 11, being equal in length as well as the angle of their declivity, a heavy body placed upon A. would descend to the end of either B. or C. in the same portion of time ; but if the horizontal basis of the inclined

plane,

plane, A. B., was changed to the perpendicular
line, A. D., the same body would move down the
whole length of the plane A. 80, in less than one-
fifth part of the time, according to the well-
known law which has been referred to at page 10.
Now as the space A. 80, which the distance pas-
sed over by the heavy body in descending from
A. to B., represented by A. E., but upon a hori-
zontal plane line, is little more than a fifth part
of the similar plane, A. C., which is the same
as A. B., which *must*, by the connection between
the two wheels, be passed over in the same time,
it follows, that the velocity of the body moving
from A. to B. 10, is more than five times great-
er than the velocity of a similar body, moving
from A. to E. in the same time; and the friction
from A. to E. being equal to the friction from
A. to B. 10, it follows, that as from A. to E. is
less than a fifth part of the distance from A. to
B. 10, it follows, that the friction which is ex-
perienced by a body which passes from A. to B.
10, while the planes of the wheels are connected

in the manner that has been described, is only
equal to the friction from A. to E., or less than
a fifth part of the friction which the same body
would experience, in passing down the same
plane, when moving merely by its own velocity.

The whole power of the machine is, while
the active wheel remains in a vertical position,
compounded of the weight of that wheel acting
by its own gravity, and set in motion by any ex-
traneous power: but if the axis of the active
wheel be placed in a horizontal position, though
still at right angles, with the axis of that which
is called the passive wheel, it is immediately de-
prived of all the power which it derived from the
gravitation of its own matter, or that matter
which was impressed upon it, and retains only
that which it derived from the extraneous power,
and communicates to those wheels which are
connected with it, and with a velocity propor-
tioned to the relative proportions of the wheels.

We have now acquired a knowledge of three
distinct kinds of power, which may be introduced
into

into machinery by the use of these wheels; first, that which is derived from two or more of the wheels which have been called passive, and possessing powers superior to the powers of all other wheels that have been used with similar intentions; secondly, of power and velocity to any extent, by combining the active and passive wheels, and taking advantage of the gravitating power of the matter which may be connected with that wheel; and, thirdly, by connecting the active and passive wheels, but relinquishing the advantages which may be derived from the gravitating power of matter. To these may be added a fourth kind of power, *viz.* when two or more of these wheels, which have been called passive, but which may be combined together, so as to form a moving power, are so combined, of which the following may be stated as an example.

Let A. *Fig.* 12, represent a wheel of any given size, turned by the small wheel or pinion B. If A. has seventy-two teeth, and B. six, twelve revolutions of B. will produce one revolution of A.

according

according to the proceeding described by *Fig*. 1,
2, and 3, which is that of a number of small
levers turning one large one, according to its own
power, but diminishing the effect and velocity of
that power, by the slowness of their own motion
and the effects of their friction.

Let A. and B. *Fig*. 13, represent two
wheels of the same dimensions, but with the
inclined plane teeth. Let A. have twelve teeth
in its circumference, and B. one. One revolu-
tion of A. would still be produced by twelve
revolutions of B., but with powers in every
respect different.

As the twelve teeth of A. over-lap each other
on the face of the wheels, according to the descrip-
tion given at page 17, each of them will be equal
in length to one-sixth of the circumference of
the wheel. Let the diameter of the wheel be
twelve inches, and the length of each of the
teeth will be six. Each of these teeth acts as a
lever of its own length, and is placed at a station
of thirty degrees *within* a right angle of its cir-
cumference,

cumference. This arrangement constitutes a
series of compound levers, *viz.* first, a series of
levers six inches long, within the circumference
of the wheel, and, secondly, another series of
levers of equal length, acting upon the extre-
mities of the former, at an angle of thirty
degrees, within a perpendicular line, drawn
from the extremity of the wheel; or one hun-
dred and twenty degrees from the extreme end
of the tooth, when it is laid in a horizontal
line from the axis of the wheel : these teeth are,
at *least,* equal to a series of levers double the
length of a spoke of the wheel, as explained by
Fig. 14. Take the length of the teeth, and add
them to the diameter of the wheel on every side,
and it will double that diameter, thus we shall
have a circular series of levers, equal to a wheel
whose diameter is twenty-four inches, perform-
ing their revolution in the SAME time as a wheel
whose diameter is only twelve inches, and with-
out the impediments which a wheel of that dia-
meter, but made in the common way, would ex-
perience,

perience, from the increased surface and friction
occasioned by its construction, as described by
Fig. 1 and 2.

The wheel, or pinion, B. Fig. 15, being
but a single tooth turned round a cylinder, will
be but one inch in diameter, and therefore will
have powers, in proportion to its size, much great-
er than those of A. It has been shewn, that
the wheel A. is equal to a series of levers, whose
length *when taken collectively,* is double that of
the diameters of the wheel: but the wheel B.
being but one inch in diameter, though equal in
power to a single lever of six inches, with no
impediment but that of motion upon its own
axis, hence it would seem, that in estimating the
power of B. at only six times that of a wheel of
the same size, but of the common construction,
it is much under-rated : but, letting it so remain,
and estimating A. at twice the power of its cor-
responding wheel of the ordinary construction,
and the power of the two inclined plane
wheels, will be as twelve to one of the common.

But

But we are entitled to add two more, on account
of the increased surface created in the latter, as
has been explained at Page 4, and therefore are
entitled to estimate the power of this pair of
wheels at fourteen to one, as the power of the
common wheels.

In attempting this demonstration, it has
been confined, throughout the whole, to the
single angle of eighty degrees, for the sake of
comparing one part with another; but the same
reasoning will apply to wheels, cut upon inclined
planes of every different angle, the general laws
remaining the same, though the particular mo-
difications will produce different effects, both of
velocity and power; and the skilful mechanic
or machinist will perceive, that they have now
the means of producing almost infinite varia-
tions and effects of power, which were not,
previously, within their reach. To their re-
flections, the subject might now be left with
safety; but, for the sake of others, it may not
be useless to compare the two systems as appli-

cable

34

cable to some simple machine, for which pur-
pose the common wind or water mill has been
selected.

Fig. 1, pl. 2, indicates the machinery of
the ordinary mill. A. is the axis, communi-
cating with the moving power (which is not
represented), and sets the whole machine in
motion; B. is the cog-wheel, which sets C., the
vertical wheel, which moves the stone, in motion.
B. has sixty-one teeth, or cogs; C. has ten teeth;
consequently, one revolution of B. produces ten
revolutions and one-tenth of C.

Fig. 2 indicates the position, of a set of in-
clined plane wheels, which might be inserted
in any existing mill, being made of the same di-
mensions as the common wheels to be removed.

A. is the axis, connected with the moving
power (which is not included in the view). B.
is a large inclined plane wheel, which consists of
ten teeth, and turns C. which has but one tooth.
C. communicates by a spindle with the active
wheel D., whose axis is laid horizontally, and
turns

Fig 1.

C

A

B

I

K

D

G

E

C

F

Fig 2.

A

B
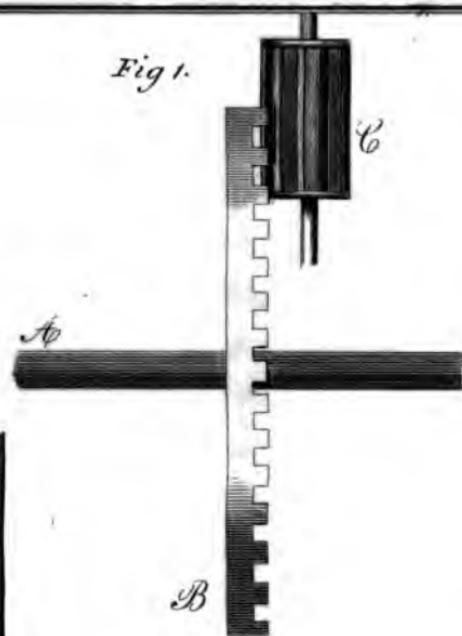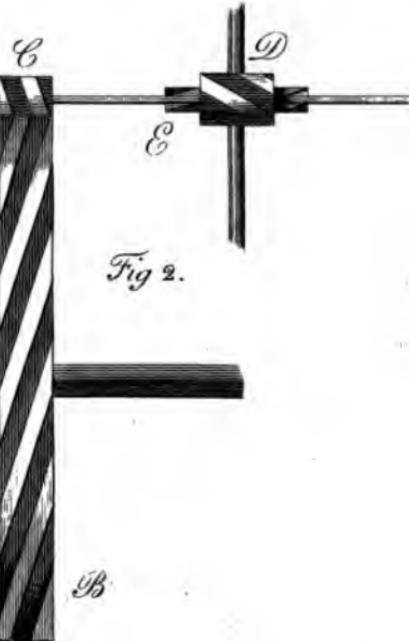
turns E., whose axis is vertical, and puts the
stone in motion. Let the teeth of D. and E. be
so proportioned, that one revolution of D. shall
produce one revolution of E: one revolution
of B. turns C. ten times round; so that the
number of revolutions of the stone, will be
the same in either mill, in proportion to one
revolution of the moving power; but the differ-
ence in the performance of the two mills will,
according to the explanations already given, be
as fourteen of the inclined plane wheels, to one
of the old mill.

But the power of making great additions to
the performance of such a mill is still within our
reach, if it was to be built according to the fol-
lowing plan. With the wheel B. connect the
active wheel F., according to the rules which
have been already explained. If wind is the
moving power, connect a spindle with F., and
pass it through the roof, to be connected with the
sails of a *horizontal* windmill. If the moving
power is water, connect F., by means of a pas-

sive wheel, G., fixed upon any convenient part
of its circumference, and, by means of that
wheel, and a small active wheel H., connect it
with the axis of the water-wheel; the consequence
of that combination will be, that we shall acquire
the means of greatly increasing the powers of such
machinery in several ways ; first, by increasing
the power of the active wheel, F, to any extent
we please, according to the rule that has been
already explained; secondly, increasing the num-
ber of teeth in F., *ad libitum*, so as to increase
the velocity and number of the revolutions of
B. to any extent we please, and still further in-
creasing the velocity and power of the whole
machine, by varying the relative proportions of
G. and H. and D. and E., to produce any effect
we wish to obtain : but there is still another
source of power to be explained.   In F. 2. the
moving power is applied to the axis of the wheel
B., the resistance from friction and the body to
be acted upon, is applied on its circumference,
and much of the moving power must be occu-
pied

pied in overcoming that disadvantageous state
of the resistance: but in a mill of the construc-
tion indicated in F. 2., it will be seen, that the
moving power will be applied to the circumference
of the wheel, in the first instance, by which
a vast accession of power will be gained. By
combining all these circumstances together, cal-
culations might be formed, to shew what ef-
fects might be produced : avoiding, for the pre-
sent all calculations upon extensive or compli-
cated machinery, it will be sufficient to shew
what may be done to increase the power of the
mill that has been already mentioned.

' Suppose the moving power of wind or
water that is applied to turn *Fig.* 1. or the
improved *Fig.* 2. is equal to one hundred pounds,
that would be the whole power which would
act upon either set of wheels, according to the
rules which have been laid down ; but if we
were in want of great power we might, *without
inconvenience*, in a mill of the common size
that is used to turn a single pair of stones,
make

make the active wheel F., a column of cast-iron
that should weigh eighteen cwt., or with little dif-
ficulty or inconvenience, a much greater weight ;
but for the purpose of this illustration, we will
make it eighteen cwt., this acting upon teeth
cut of the angle of eighty degrees, will, accord-
ing to the known laws of heavy bodies moving
down inclined planes, constitute a power equal
to the direct pressure of sixteen cwt., existing in
the machine : set this in motion by the moving
power of one hundred pounds, applied to the
axis T. &c. &c. &c., the whole power of the
machine will be found by multiplying sixteen
cwt. by one hundred lbs., the product will be one
hundred and seventy-nine thousand two hundred
pounds ! from which, of course, the friction of
the machine is to be deducted, and then, even
after making great allowance for the difference
which frequently takes place between the com-
puted power of machines, and their actual per-
formance, the power that would be thus introdu-
ced into the mill would still be enormous.

From

From this statement it is evident, that
within the space which is now occupied by a
common mill, an engine of most uncommon
power might be constructed and kept in motion
by the same moving force which is used to work
the common mill; of course, where nothing
more than the force of a common mill is wanted,
it may be obtained within a less compass and
kept in motion at a less expence of power and
of money, than by the usual system of wheel-
work : if to this we add the power that may
be obtained in engines of the greatest magnitude,
by setting machinery of this description in
motion by the power of steam-engines of the
sizes that are already in use, we shall be
enabled to form some idea of the wonderful
increase of power, where increase of power is
wanted, or the great diminution of expence
where a limited power only is wanted which
this invention puts within the reach of every
person whose pursuits are connected with machi-
nery of any kind.

The

The author of these papers was led to make the discovery which he has now attempted to communicate, by the unremitting attention of many years to a favorite subject in mechanics, which the experience of those years convinced him could never be attained by any of those combinations of the mechanic powers which were already known : this conviction drove him into the wilderness of experiment, where he was so fortunate as to find what he wanted. The facts of which he thus obtained the knowledge, could not remain long under his observation without convincing him that they depended upon *some general laws*, which it became his business and his pleasure to investigate; that investigation led him to the discovery which he has now endeavoured to communicate, and induced him to believe that it might afford great advantages to many departments of mechanical science. if it was made public; therefore, having taken out a Patent to secure the fair advantages of his discovery to himself,

he

he is preparing to lay those inventions before
the public, to which he means to apply it,
as soon as they are sufficiently brought to
maturity; he now publishes this account of the
properties of his invention, that every one who
chuses may use it in his own way, upon terms
which will be equitable to all parties, and which
will be more particularly explained in the
preface.

*Description of a moving Power for a Crane,
Windlass, or other Machinery of that De-
scription : of a moving Power to be added to
the Capstan and Chain Pumps, by the Addi-
tion of which the Quantity of Work, that may
be performed by those Engines will be greatly
increased ; and of a horizontal Rudder, by
the Application of which, Vessels of various
Descriptions may be impelled with great Ve-
locity either with, or against the Tide or
Stream, at the same Time that they will re-
main obedient to the Action of the common
Rudder.*

G   When

When the preceding pages were printed
they were intended for immediate publication;
but an unexpected delay in the progress of the
patent, which it was necessary to have complete
before the invention could be made public, oc-
casioned that publication to be delayed for some
time ; this delay was vexatious on some accounts
but, perhaps, advantageous on others : it afford-
ed the author time to complete working models
of some machines, to try their powers, and esti-
mate the difference between the powers of those
improvements and of the original machines upon
which they have been made.

The first, see plate 3, *Fig.* 1, is what is techni-
cally called the letter A crane, because the profile
of its frame bears some resemblance to the roman
capital of that name ; this is a portable engine
of considerable power ; it is used for many pur-
poses, *viz.* to raise goods from, or lower them
into a ship's hold; to raise stones in building,
weights for driving piles, and many other pur-
poses ; as the machine is so well known we shall

not

not notice the minutiæ of its construction, but only describe its moving powers generally, to compare them with those which are to be ac-quired by adapting the inclined plane wheels to them.

The large wheel is two feet in diameter and contains sixty-one teeth; the small wheel is four inches and a half in diameter and has six teeth; thus ten revolutions of the small wheel will pro-duce one revolution of the large one, wanting one-sixth, but, for the sake of simplifying the calcu-lation, we shall say that the large wheel has only sixty teeth, and that ten revolutions of the small wheel will make it revolve once completely round.

The barrel or cylinder, round which the rope is coiled, is six inches in diameter, the dia-meter of the large wheel by which the cylinder is turned is two feet, and the handle or winch by which the small wheel, or pinion is turned, is fourteen inches long: the apparent consequence of this proportion of parts is, that every time the pinion makes one revolution, the moving power

travels

travels over a circle whose circumference is seven feet; and, as ten revolutions of the pinion produce one revolution of the large wheel, it seems to follow that every time the great wheel, and consequently the cylinder, makes one revolution, and thereby the body moved goes the distance of eighteen inches, the moving power travels over a space of seventy feet, but this is not the whole of the motion.

It has been shewn at page 2, &c. &c. *Fig.* 1 and 2, plate 1, that the space which exists upon the surface of the teeth of a wheel, is nearly three times as much as it would be upon the surface of the same wheel, if it was perfectly plane, and the friction of the moving power must be exerted upon two thirds of the face of the wheel, or of its teeth during the whole of its motion; therefore, the actual circumference of the great wheel being six feet, the line of motion over it, will, in every revolution, be eighteen feet, which multiplied by seventy, the amount of ten revolutions of the moving power,
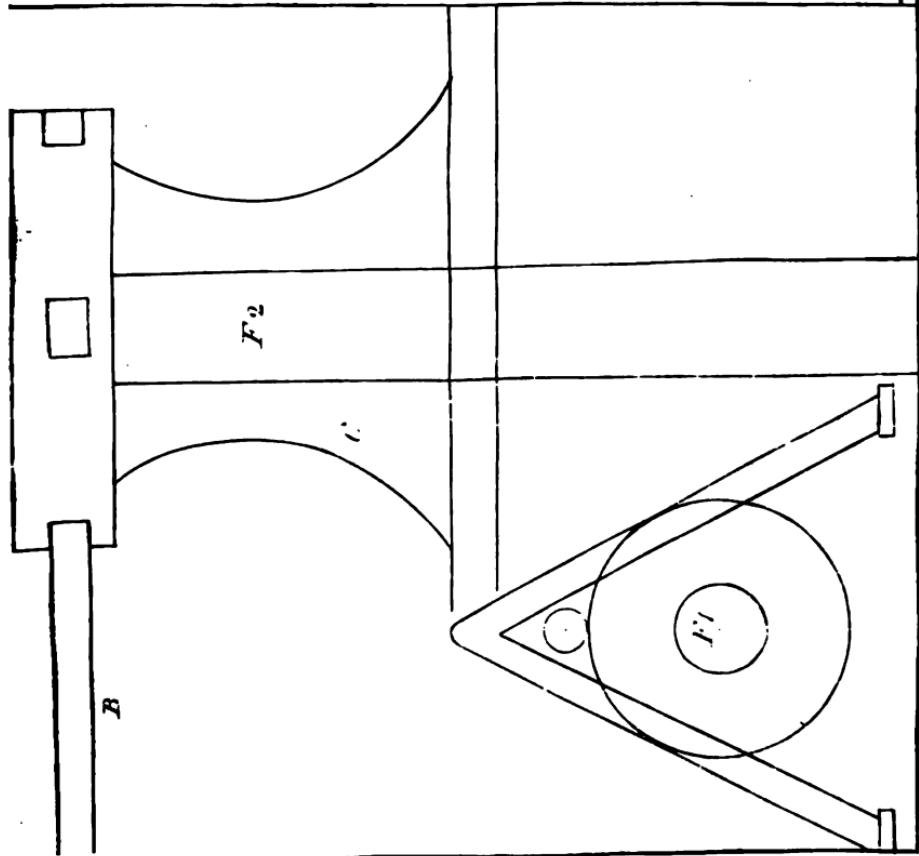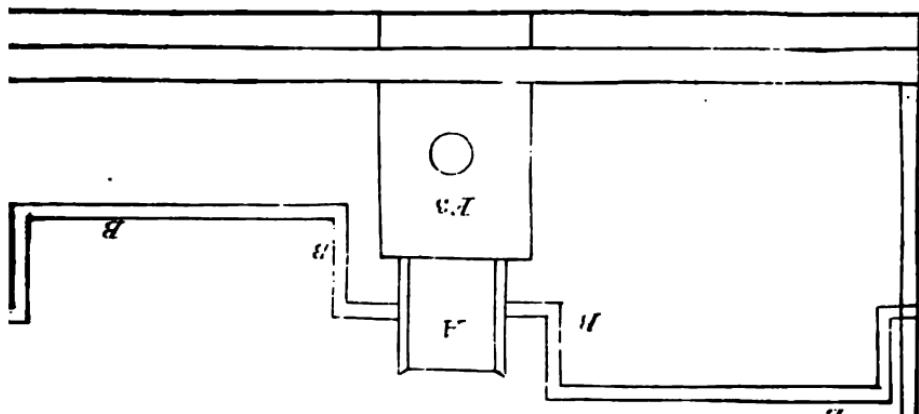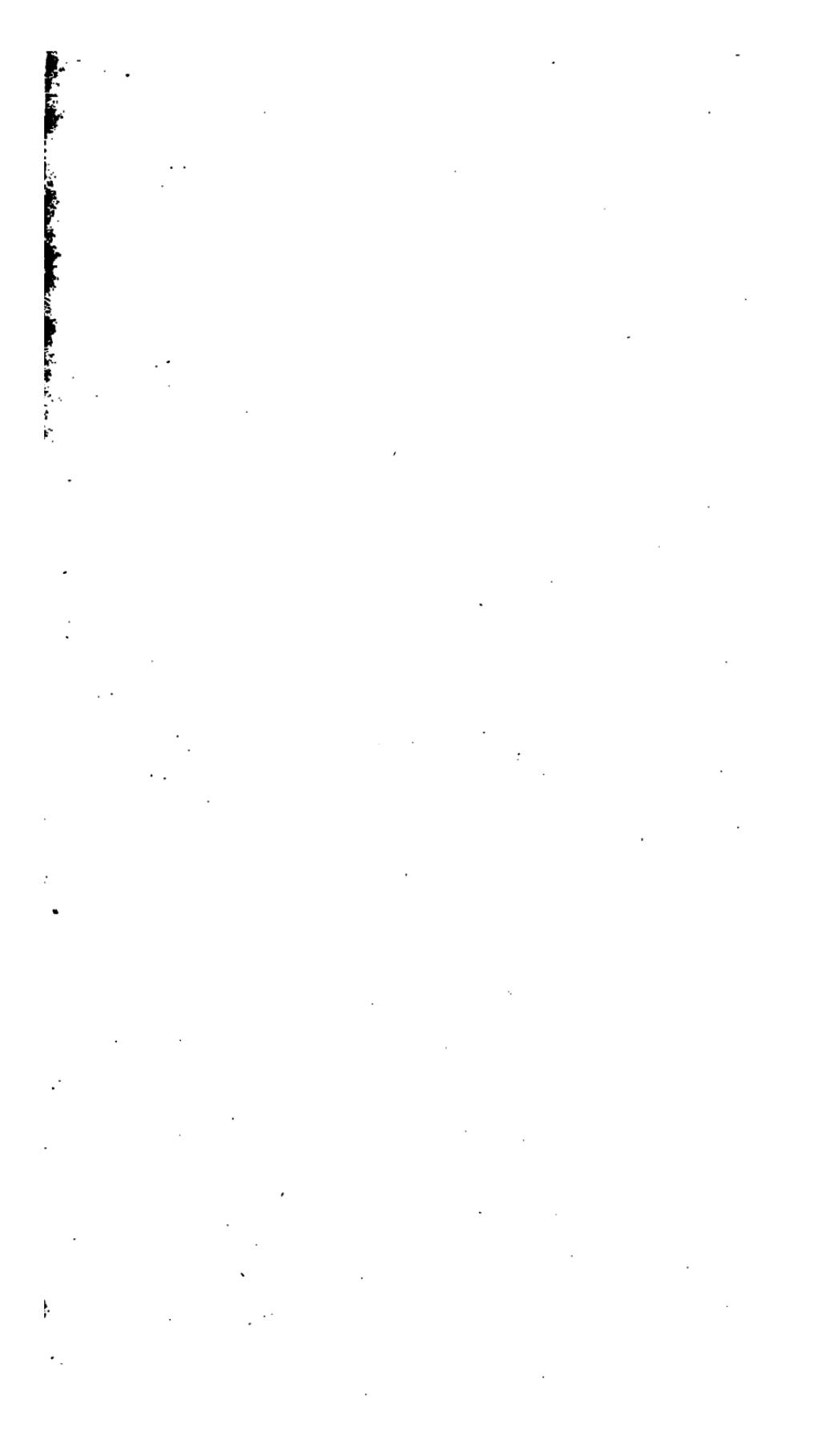
power, will give twelve hundred and sixty feet as the line of motion, described by the moving power to impel the body moved over the space of one foot six inches.

This completely exemplifies the generally known principle, that in proportion as you gain power in the construction of machinery, you lose time; and seems to confirm the opinions of those practical men, who say that in the construction of mills and other machinery of that description, they estimate that two thirds of the power and of the time that is employed, will always be occupied in overcoming the friction of the wheels; the remaining third will be occupied in performing the work.

If this machine is constructed of the same size and general proportions of its parts, and the inclined plane wheels of the same diameters be substituted for the common wheels, it is presumed that the following advantages will be gained.

If

If the angle of eighty degrees is adopted
to form the teeth, the large wheel will have but
ten in its whole circumference, and the small
wheel or pinion, but one : as it has been de-
monstrated, that whatever power will turn a
parallel tooth, will, in the same time, drive a
tooth which is cut upon any angle of an inclined
plane to whatever length it may extend, *pro-
vided all other circumstances are equal*, it is
presumed that this machine, by changing the
wheels, and leaving all its other parts in their
original state, will perform the same work in a
sixth part of the time, or six times as much work
in the same time, that it can be performed by the
common machine.

This increase of power, great as it is, will
be effected by only one point of the invention,
viz. by substituting inclined plane wheels for
wheels of the common construction ; one ex-
ample only has been given, and a working model
of this machine has been made to demonstrate
its power ; but it is presumed that wheels of the
same

same description and of all dimensions, are appli-
cable to every kind of work where power and
velocity are wanted, and where wheels are em-
ployed, whose axes work parallel to each other.

The second point of the invention and its great
importance, may be exemplified by shewing its
application to increase the power of the capstan ;
and as the capstan of a line of battle ship performs
the greatest, as well as the noblest, duty which
that engine is ever applied to, and as the greatest
power that can possibly be used, to force it into
action, is there used when necessary, the power
and dimensions of such a capstan, as they have
been received from a captain in the navy, will be
stated, to explain the nature and extent of the
improvement that may be made, by applying this
invention to it.

The annexed *Fig.* 2, plate 3, will convey
an idea of the *general* form of the capstan, for
the purposes of reference ; the minutiæ of whelps,
lifters, pawls, &c., or peculiarities in the mode of
fixing

fixing in the vessel, will not be noticed, as they are not concerned with the present discussion.

A. the drum head, 6 feet in diameter.

B. the capstan bars, twelve in number, each 18 feet long.

C. the pillar of the capstan, tapering from the deck upwards, 6 feet diameter, in the largest part.

Six men are stationed at each capstan bar, and two at each swifter, that is, ninety-six men in the whole.

Such are the dimensions of this engine, and such is the power which is thought proper to set it fairly to work; let us now examine the particulars of its action.

It is estimated that fifty pounds is the maximum of power that one man can exert, when constantly employed in moving machinery; multiply that by ninety-six, and the product will be four thousand eight hundred pounds, the whole of the moving power.

The

The men who are stationed at the swifters, and at the extremities of the capstan bars, exert the whole of their force upon the extremity of the circle, but the second, third, &c. man, stationed at each bar, loses a part of his power, as he recedes from the extremity of the bar, towards the centre of the circle; but, for the sake of simplifying this estimate, we will suppose that the whole four thousand eight hundred pounds is applied at the extremity of the circle.

The diameter of the drum head being six feet, and the length of the capstan bars eighteen ; it is probable that one foot of each of the bars will be inserted in the drum head, consequently the diameter of the circle, which is described by the extremities of the capstan bars, will be forty feet ; and, as the diameter of the capstan's pillar is six feet at the largest part, it follows, that a moving power of four thousand eight hundred pounds, travelling round a circle whose circumference is one hundred and twenty feet, moves the body, upon which it is to act,

H   eighteen

eighteen feet in the same space of time; this effect of a capstan is reducible to that of a lever, or balance, placed upon a moveable axis, and the smaller power placed at the extremity of the long lever, moves the heavier body at the end of the shorter lever, in equal times but with different velocities, proportioned to the different lengths of the levers.

One inconvenience of this engine is, that the greater part of the moving power is mere muscular power, put upon the stretch when it is called into action, and kept so the whole time, subject to variations from fatigue, and many other causes; so that, if the strength of some of the men should fail, or any additional resistance, as from a stroke of the sea, should be made upon the vessel, the capstan instantly will recoil, and with a velocity that is often highly injurious to the men. The circles which are described by the extremities of the capstan bars, being, to the pillars of the capstan, as one hundred and twenty feet to eighteen, it follows, that if

any

any stroke from the sea, upon the vessel, makes
her recoil but a single foot, the men at the cap-
stan bars must inevitably be driven back more
than six feet and a half, and with a velocity more
than six times greater than that with which they
moved forward, over the same space ; and in the
same proportion for any length of the recoiled
surge that the ship may make ; it is impossible
that the men should either resist or get out of the
way of this effect of the surge, and they must,
therefore, be thrown upon the deck with irresis-
tible force, and often receive the most serious
injuries. It is true that the pawls are applied to
prevent this, and frequently succeed in doing so ;
but the circumstance has been stated, because it
is the necessary consequence of the principles
upon which the capstan acts, and because the
capstan, which will soon be described, will not,
from the principles upon which it is constructed,
be so liable to the same defect.

For the capstan that has been described, let
us substitute one of *equal dimensions*, but made

upon

upon the principles that have been developed in
the preceding pages, and see what effect it would
produce, if set in motion by the same moving
power. Let the active wheel, *Fig.* 9, plate 1,
be the pillar of the capstan, and the passive
wheel, *Fig.* 10, the cylinder, upon which the
messenger is coiled to raise the anchor; the drum-
head, and the capstan bars, will be of the same
dimensions as those which are attached to the
former capstan, and the same number of men
will be stationed to work it.

The pillar, the drum-head, and the other ap-
pendages to the capstan that have been described,
will certainly not weigh less than two tons; and,
as the specific gravity of cast iron is, to that of
oak, nearly as eight to one, the capstan might be
made to weigh sixteen tons, without exceeding
the size of the existing capstan, if there could pos-
sibly be occasion for such a power as a body of
that size would produce; let us, however, keep
within the weight, as well as the size of the
existing capstan, and make the pillar, with the
drum

drum head, active wheel, &c. weigh thirty-six hundred weight ; let the angle of the teeth of the wheel be a plane of eighty degrees ; and, according to the laws that have been already explained, we should have in the capstan an inherent power, equal to the direct pressure of thirty-two hundred weight ; multiply this by four thousand eight hundred pounds, the whole moving power to be applied; and the product will be seventeen millions two hundred and three thousand two hundred pounds ! !

Such would be the moving power that might be called into action, by the captain of a line of battle ship, to do that duty which actually is performed by a moving power of four thousand eight hundred pounds. It may now be proper to enquire, what is the maximum of effect that might be produced by these two machines ?

As the capstan bars, &c. of the common capstan, form levers more than six times longer than that on which the body to be moved will rest, it follows, that they will balance a body which

which weighs six times their own power, *i. e.*
~~two hundred and eighty-eight thousand~~ pounds,
from which is, of course, to be deducted the
friction of the machine ; but the capstan which
has been described, will likewise balance a body
which is six times its own weight, *i. e.* balance a
body that weighs one hundred and three millions
two hundred and nineteen thousand two hundred
pounds ! ! It is, perhaps, impossible that this
power should be wanted, but as it may be given
to the capstan without any inconvenience, and
as it will not occupy more room in the ship than
the common capstan, there can be no impro-
priety in having *so* much power at command, in
case it should be wanted ; it may be abated, by
putting fewer men to work it ; and in this way
the power may be diminished at pleasure, till,
by employing one man only, above what may be
necessary to overcome the friction of the machine,
that one man will balance a body that weighs
one million and seventy-nine thousand two
hundred pounds : consequently, the power of
one

one man, over and above that power which is necessary to overcome the friction of the machine, will produce a greater effect than can be produced by ninety-six men, when applied to the capstan that is now in use.

As the number of hands that are employed in ships of war are abundantly equal to every duty, the mere saving in labour that may be produced, by adopting this capstan in such vessels, may not be an object of primary consideration, although the *increase of power* may : for, it is understood, that it is not a very uncommon occurrence for a ship to leave her anchor behind, for want of power, under some circumstances, to raise it; but, to mercantile vessels of large burthen, which carry but few men, it is presumed that this will be an acquisition of great importance, as it will enable a small portion of the few men they carry to perform that duty with ease, which, with the common capstan, requires the greatest exertion of a large body of men to effect; and, in situations where the capstan can

be

be used on shore, and where the wages of men constitute an object of great importance, it is presumed that this invention will be found of great value, as producing a great saving of expence, as well as giving a very great increase of power in any given space.

The great saving of time is of quite as much importance, as the increase of power in a given time, and perhaps more unexpected, as it is a fact totally repugnant to the received doctrines of mechanics, which have been supposed to be universally true; this being the case, and the present opportunity being favourable, it will be proper to show how the power and the velocity of this capstan may still farther be increased, so as to perform any work it may be applied to, in much less time than the same work can be performed by any other means whatever.

It has been demonstrated, page 9, &c. that whatever powers can completely turn a parallel tooth, will, in the same time, drive a diagonal formed tooth, the square of whose diameter is
the

the same, to any length of an inclined plane to which it may extend, provided that all other circumstances are equal; and it has been demonstrated, page 18, &c. and by the wheels which are in my possession, that when two wheels, each of which consists of any number of teeth, whatever the relative numbers of their teeth may be, are combined with their axes at right angles to each other, the surface of that wheel whose teeth are turned round its axis, will pass over a space five times and a quarter more than the other wheel, whose teeth are inclined parallel to its axis, and in the same portion of time: let us suppose our capstan is formed with those very teeth, and see what will be the consequence.

Let the passive wheel, plate 1, *Fig.* 10, represent the cylinder round which the messenger is coiled, and *Fig.* 9, be the pillar of the capstan by which it is set in motion; the nine teeth of the active wheel will be completely turned and moved over a space equal to their diameters, by one revolution of the moving power, which,

in

in making that revolution, travels over a space of one hundred and twenty feet; and, in *the same time*, the passive wheel according to the demonstration, p. 18, makes two revolutions and one fourth; *i. e.* if it measures six feet in diameter, it will raise the weight which is attached to the cable eighty one feet, in the same time that the common capstan would raise it eighteen feet, supposing the other powers of the two capstans to be equal, so that the velocity of the body moved, would, in this case, be to the velocity of the moving power as eighty-one to one hundred and twenty, instead of being only eighteen to one hundred and twenty, which is the velocity of the body moved to that of the moving power, as applied by the common capstan of equal dimensions.

We shall now endeavour to shew how the power and velocity in the performance of this capstan may be increased, without increasing its general dimensions, or increasing the quantity of the velocity of the moving power.

In

In order to do this, it will not be necessary
to increase the size of the passive wheel; and,
as it is, in this particular case, desirable to keep
the machinery in a small compass, it will be
advantageous to let it remain of its present size:
the active wheel and the column of which it forms
a part, weighs 36 cwt., it consists of nine teeth
and their correspondent spaces, and if the dia-
meter of those teeth was two inches each, the
circumference of the whole would be thirty-six
inches: if one tooth was added to the number,
the circumference of the wheel would be in-
creased four inches, and the weight of the co-
lumn would be increased four hundred weight,
if the same proportions were preserved.

Thus we shall add three hundred and ninety-
eight pounds to the power of the active wheel,
and nine feet to the velocity of the passive wheel,
of course so much to the progress of the body
moved, without adding any thing to the quan-
tity or the velocity of the moving power; and
if we increased the number of teeth to eighteen,

we

we should impel, drive, or raise the body moved,
over the space of one hundred and sixty-two
feet, in the same time that the moving power
passes over one hundred and twenty feet; and
it is evident that by increasing the proportional
number of teeth, and consequent weight of the
active wheel, the power of the machine, and
the velocity of its motion, and consequent in-
crease of its effect may be continued to any ex-
tent without increasing the power that keeps it in
motion.

The result of these calculations is so differ-
ent from any thing that has been known, or
ever believed to be possible in mechanics, that
I should hesitate in making them public, if I
had not the wheels upon which they are made in
my possession : of the existence of these, there
can be no doubt ; if there are mistakes in the
calculations that are made upon them, those
mistakes may be discovered, and corrected; and,
between the performance of the machinery
which has now been described, and the theory
upon

upon which it is founded, there may prove to
be that kind of difference which frequently ex-
sts between calculation and practice : yet, after
every possible allowance can be made upon this
subject, it is presumed that much advantage will
be derived to the community by adopting it.

It will be proper to mention some peculiari-
ties in the form of this capstan, from which it is
presumed that no inconvenience will arise, and
others which it is presumed will, in some situa-
tions be advantageous.

The common capstan moves upon a vertical
axis, round which the cable or messenger is
coiled ; but, in the capstan which has been de-
scribed, the pillar will remain vertical, but the
passive wheel round which the cable, &c. is coiled,
will move upon a horizontal axis : this, it is
understood will make no difference as to the fa-
cility of delivering the cable, &c. into the hold,
nor will it in fact, occupy more room upon deck
than the common capstan, the diameter of the
drum-head of which, as well as the capstan
itself,

itself, is six feet; if the same drum-head is preserved, the passive wheel and the body of the capstan which is connected with it, need not occupy more than three feet, so that it would still stand under the same drum-head and occupy no more room upon the deck than the old capstan.

If it should be desirable, the same active wheel and capstan may be made to turn two bodies at the same time, and these may be so managed, that they will be worked by the same motion of the moving power in the same time, and so arranged that they may both raise the bodies they are applied to, or one may be raised and the other lowered at the same time, by the same action of the moving power. If this construction is adopted, it may occupy a foot more than the diameter of the drum-head, upon the deck, and it will of course be for nautical men to decide, whether the occupation of *so* much space will be any inconvenience, or whether the acquisition of a double capstan, such as has been described,

described, will be of use to them; but it is presumed, that in situations on shore, the double capstan will be an important acquisition, as it may by a simple arrangement of proper tackle, be made to work two cranes, with the expence that is necessary to work one, and either of these cranes may either raise or lower its weight at the same time with the other, or one may raise while the other is lowering, and without loss of time or interfering one with the other.

Notwithstanding this discovery is new in all its parts, as it depends upon the new application of mechanical principles, which have been known to mankind as long as any demonstration of mathematical truth, it will not be unreasonable to suppose, that some similar combination of the same principles has been known in former ages, and, to confirm the probability of this conjecture, the following facts may be mentioned.

In the ruins of the temple at Baalbec, are said to exist stones, which measure sixty feet

in

in length, and are of proportional height and breadth; they are raised to a considerable height from the ground, and were certainly placed in their present situations by the hands of man, although the builders and the means they made use of, are equally unknown to us; at Persepolis, in Egypt and in India, are said to be buildings of unknown antiquity, which contain many stones of equal magnitude; as it is impossible to believe, that any human force could effect such works without the aid of science, and as it is presumed, that by such a capstan as has been described, such stones might be moved with as much ease as modern builders can raise any stones which they wish to employ, it is not unreasonable to suppose that some modification of the principles which have now been developed, was well known to those who constructed the buildings alluded to.

In Sicily, again, exist the remains of the Temple of Jupiter Olympius, which is constructed upon a scale so vast, that Denon says, the volutes

volutes in some of the columns were large enough
for a man to stand in : here, stones of immense
magnitude, such as no modern builder would at-
tempt to put together, are to be found; Sicily
possessed all the science of ancient Greece, and,
in all probability, might possess engines which
were formed by some similar combination of
these principles, although the knowledge of
these engines have been lost in the ruins of Gre-
cian art, knowledge and science.

When Marcellus besieged Syracuse, the be-
sieged made the most obstinate resistance, and
among other devices of destruction, with which
they were supplied by the inventive genius of
Archimedes, it is said they had one with which,
as soon as the Roman ships approached the
walls, they seized, tore them suddenly out of
the water, and instantly dashed them to pieces
against the walls, to the utter destruction of the
vessels and their crews : few facts in ancient his-
tory are better attested than this, yet the means
by which such wonderful effects were produced

are

are entirely unknown. The Romans were, at best, and at all times, but the apostles of destruction; in the time of Marcellus they were, as to matters of science at least, but ignorant barbarians; they were irritated to madness by the destructive resistance that was made to their power; when, at last they obtained possession, they destroyed the place, murdered the mathematician, and demolished his engines with the most savage fury; though they afterwards repented, and wished they had been preserved, no doubt, that *they* might turn them to the destruction of those who might afterwards oppose them: but the wish was in vain, every thing connected with the fact was buried in eternal oblivion, except the remembrance, which the inferior state of modern science seems to render improbable, that such things once existed.

It is not pretended that the means, which were actually used to produce the above mentioned effects have been discovered; but, if any conclusions may be drawn, by fair induction,

from

from the facts which have been stated, it may be presumed that by the application of those modifications of known mechanical principles which have now been developed, effects may be produced which will equal, if not exceed, whatever has been done by the application of human power or science to machinery.

Having given two examples of machines, which have been constructed by applying the two simplest combinations of this invention, it is intended to add a third, in which two of the simple powers are combined: for this, the chain pump of a line of battle ship will be selected, because it requires great power to make it act with effect, and because, from the circumstances of the case, it is much limited with respect to the space which it can be permitted to occupy.

Chain pumps are constructed in various manners, the peculiarities of which it is not intended to investigate, but it will be supposed that the best construction has been adopted, and

it

it is intended to increase the powers of a pump
so constructed, by adding so much of the pre-
sent invention as may be applied, to carry the
execution of that pump to the highest degree
of perfection of which it is capable.

The following dimensions of the chain pump,
and of the powers which are employed to work
it, have been ascertained to be correct, and they
may be better understood by referring to the
annexed figure 3, plate 3.

A. Cylinder or barrel over which the chain
passes, 2 feet diameter, B.B.B.B. The handles
by which the barrel is turned; to the axis which
passes through the barrel, its ends work in
stanchions which are fixed into the upper and
lower decks, the circles which the handles de-
scribe are 3 feet 8 inches in diameter. Twenty-
four men may be employed, as a full comple-
ment, to work this pump with the best effect.

The power that can be exerted by twenty-
four men in working this pump, will be twelve
hundred pounds, the circle which the handles
describe

describe being 3 feet 8 inches in diameter, in making one revolution the moving power will travel over the space of eleven 'feet, and the diameter of the cylinder being 2 feet, that revolution will deliver a body of water from the pump, which shall equal the dimensions of the boxes and be six feet in length. Soon after the pumps are set in motion, they will acquire their maximum of velocity, and all the subsequent exertion, whatever the urgency of the case may be, will be employed in keeping the work of the pump up to that maximum.

If there is any situation, in which imperious necessity demands that the greatest power, which human ingenuity can produce, should be instantaneously obtained, it is that of a ship at sea, when her chain pumps are set to work ; the water gaining upon the hold ; the men all fatigued with their exertions, the fatigued men who are sinking at the pumps, relieved by those who have not recovered from that fatigue which has already been produced, and, after every nerve has

has been strained to the utmost, scarcely a hope remaining that the water shall be so far reduced, as to put them in a state of safety; it is then that the application of this discovery may be eminently useful.

It is presumed that, wherever chain pumps are to be used, the best, or those which are supposed to be the best constructed will be employed; it is therefore proposed that, when this invention is adopted, every part of the original pumps shall remain, only making such alterations as shall be necessary to adopt the improvements to them.

Acting upon this principle, let the passive wheel, *Fig.* 10, plate 1, be the cylinder by which the chain of boxes is raised; let the active wheel, *Fig.* 9, be connected with it, and its axis be properly secured in the decks, above and below; this active wheel and the pillar connected with it, may, without inconvenience, weigh 9 cwt. Upon a convenient part of this pillar, place another passive wheel, which is to be worked by an active

wheel

wheel placed with its axis horizontally, which is to be turned by the axle to which the handles are attached: this arrangement will be understood by referring to *Fig.* 2, plate 2, where H. will indicate the second passive wheel, and I. the active wheel; to which the axle is attached; the consequence of this arrangement will be as follows :—

The active wheel weighing 9 cwt. will contain a power equal to the direct pressure of eight hundred and ninety-six pounds, which multiplied by twelve hundred, the power of the twenty-four men employed, will give one million, seven hundred and five thousand two hundred pounds, the moving power of the whole machine! or if two men only are employed, they will produce a moving power of nineteen hundred and ninety-two pounds, which is seven hundred and ninety-two pounds more than the whole power of the twenty-four men, when applied to the original pump.

The

The increased velocity with which this power will be exerted, will be quite equal to the increase of the power itself: one revolution of the first active wheel, will produce two revolutions and one-fourth of the passive wheel, which is connected with the cylinder over which the chain is moved, and one revolution of the axle to which the moving power is applied, will produce two revolutions and one-fourth of the first active wheel, *i. e.* one revolution of the moving power will produce five revolutions of the chain barrel; or, in other words, the moving power, by travelling over the space of eleven feet, will deliver a column of water whose length is thirty feet. This estimate of the velocity of this combination, is made upon wheels which I have made, which stand before me, which I have counted and measured, and, on this point at least, it is impossible that I should be mistaken: the estimate of their powers is made according to the acknowledged rules, by which such calculations are made,

made, and it is presumed they will prove to be correct : so far then, we may say, that we have proceeded by experiment, and may therefore, as a matter of speculation, proceed still farther.

Upon referring to the description that has been given of the capstan, it will be seen that by applying the same principles to this moving power of the chain pump, its power, its velocity, and therefore its execution may be increased in a three or four fold degree, without requiring any addition to the moving power. So much has been said upon the supposition, that the construction and general size of the original pump is preserved ; but, if farther experience should introduce this invention into general use, it may be found adviseable to enlarge the size of the pumps, so as to deliver a column of water of much larger dimensions in the same portion of time ; or, if the economy of space in naval architecture should forbid this, there undoubtedly are situations in which it is desirable to get rid of large quantities of water, in as little time and with as

L   little

little expense as possible, and in which this invention may be so modified as to produce a degree of effect of which previous experience can give no example.

Circumstances, which it will be needless to particularize, induced me to reflect, many years ago, on the possibility of impelling vessels through the water by means totally different from oars or sails; the increasing importance of inland navigation stimulated me to pursue the subject, by suggesting that, if the means of doing this could be devised, the invention, when perfected, would be a valuable acquisition to that part of our commerce; and in the beginning of last summer I prepared to put my scheme in execution. My first design was only adapted to the purposes of canal navigation; the peculiar circumstances of which imposed restraints which must have the effect of indispensable laws, or the invention, if it was otherwise completed, would diminish, in utility, in proportion as they were not conformed to; these laws were, 1st. that

the

the machinery should, in no case, occupy more
space in breadth or depth than the vessel to
which it was attached, and very little more in
height than the same vessel; 2d. that it should
perform more work in a given time, than could
be performed by the same vessel when worked
in the usual way; 3d. that it should, if possible,
be a machine which might be attached to any
vessel to whose size it was adapted; and fourthly,
that the expence of construction, keeping up,
and working the machinery, should be much
less than the expence of working the vessels to
which it might be applied in the usual way; for,
if it did not possess these advantages, it could
not be expected that it should be adopted by those
who are engaged in such navigations, whatever
power the machine might possess, or whatever
ingenuity might be displayed in its construction.

Upon these principles my first model was
completed, when a friend who resides near the
mouth of the Thames, offered me his premises
and every facility that his situation afforded to

carry

carry my design into execution; this offer was too advantageous not to be accepted with the greatest satisfaction, but it placed me in a situation very different from that in which I had originally intended to be.

It was easy to discover that, on a vessel, machinery which might produce a certain effect when tried in still water, or in a canal where the water approaches to that state, might have no effect when tried in a situation so near the sea, and of course subject to all the influence of the tides, winds, and weather in that situation; for this reason I abandoned my first design and adopted one that would be better adapted to that in which it was to be tried; viz. to try whether a larger vessel would be impelled, in this open situation either with, against, or across the tide.

The vessel adopted was a cutter whose dimensions were thirty feet in length, six feet four inches in breadth, and three feet eleven inches in depth; it is usually rowed by six men,

and

and when rowed by six good men will make six miles in an hour.

The size of the machinery was regulated by the principles that have been laid down; the impulse was given to the vessel by a water wheel fixed at the stern, and the wheels which connect- ed that water wheel with the moving power stationed within the vessel, were so combined that one revolution of that power would impel her more than seventy feet straight forwards, at the same time that she was under the influence of the common rudder, as much as if she was moved forwards by oars only; the machinery was so adapted that it might be worked by either one or two men, each or either of which might turn a winch to set it in motion, or each or either of which might apply a windlass and be assisted in working it, by at least one more man without any difficulty; so that the means were provided to work her by four men if it should, under any circumstances, be necessary; though, when it was considered that six men, with oars, each of

whose

whose power is estimated at fifty pounds, *i. e.* three hundred in the whole, could row her six miles in an hour, and the estimated power of the machinery, calculated upon the principles that have been explained, was upwards of twenty thousand pounds, it was presumed that one man would be able to drive her forwards, with at least as much velocity as the six men would, when rowing in the usual way.

The result of the experiment was as favourable as had been expected, and the particulars will be published on a future occasion, along with others which are analogous to it ; it will only be observed here, that it suggested to some gentlemen, who are thought competent judges, that the invention might be applied, with much advantage to the purposes of *general navigation* ; of this the author has no knowledge, and therefore does not pretend to judge; but presumes to think, that if it may not be so applied, as to become a permanent part of vessels intended for sea voyages, it may, perhaps, be taken on board of some ships,

ships, answering the purposes of an equal weight
of ballast, at all times, and be mounted at a short
notice, so as to be eminently useful on particular
occasions.

If this machinery should be attached to
any vessel intended for sea voyages, it must be
arranged in a manner very different from that
which will be adopted for inland navigation; in-
stead of one wheel attached to the stern, it
should consist of two wheels attached to the sides
of the vessels, either in a line with the main, or
the mizen mast, and be so arranged that the
pressure of the moving power should be against
the lowest part of the mast, by which means
that pressure would co-operate with the action
of the sails, and being applied near the bottom,
would in no case strain the vessel improperly;
each of the wheels might be worked by separate
machinery applied directly to it, or both worked
together by such a capstan as has been already
described, so as to move her directly forward,
while the rudder is left to perform its duty in the
usual

usual way; if this combination was to be effected, and the powers of the machinery have not been over-rated, it is presumed that the largest ships that ever floated, may be impelled through the water with considerable velocity; either when no breath of air is stirring, or when light winds are favourable, or with all sails furled, when such winds are adverse: the only question for consideration, is, whether the permanent attachment of such machinery to ships at sea, could be attended with any disadvantage; of this question, none but seamen are judges, and to their decision it must, therefore, be submitted.

Supposing that it should be thought right not to adopt this permanent machinery, for the purposes of marine navigation, it is still presumed, that it may, as a temporary measure, be adopted in many situations with advantage. I have been told, by gentlemen who have been in India, that, in the equinoctial latitudes, and other situations, ships are frequently becalmed for days, and sometimes weeks,

weeks, without moving from one spot on which
they seem to be fixed; it is presumed that in
such situations, a few hours might be spent in
fixing the machinery, and the ship might after-
wards proceed with a velocity, that might be
ascertained with certainty, to the end of her
voyage, with a great saving of time, and, con-
sequently, incalculable advantage of those whose
property is embarked in such pursuits.

These are, indeed, but speculative ideas;
they are ideas, however, which may easily be
brought to the test of experiment; whatever
power can impel any large vessel through the
Thames, will impel the same vessel through the
calm waters of an equinoxial latitude, and as
the machinery, if constructed with that view,
might be removed from one vessel to another,
or be converted to any other purpose, it is pre-
sumed that an expence, moderate in proportion
to the object in view, would lead to a certain
determination on the subject; should it be the
wish of those who have a manifest interest in

M   promoting

promoting such an object, the patentee will place
his discovery at their disposal, and dedicate so
much of his own time as will be necessary to
carry it into execution.

Having proceeded so far, guided in some
respects by demonstration, in others by calcula-
tion upon experiments, we shall be excused for
examining, as a matter of speculation, how far
any, and what advantages may be attained, by
applying this invention or discovery to the great
machinery of the country.

It is written (vide Encyclopedia Britannica,
article *Steam Engine*), that such is the magnitude
of the steam engines, which are employed in
some of the mines in Cornwall, *that the matter
which is lifted at every stroke*, weighs more than
one hundred tons, and that such engines will
make sixteen or seventeen strokes every minute.
It is difficult for those who are not familiar with
such subjects, to form an adequate idea of the
power which can keep such an enormous mass of
matter in motion, or of the strength of the

buildings

buildings which can bear its perpetual vibration : it is possible that the magnitude and power of such engines may be increased, but, supposing that to be the fact, the time must come when the expence of raising the engine and the expence of keeping it in action, will absorb all the profit of the concern, which then will cease.

This being a possible case, it may not be useless, to enquire whether it will not be possible, by combining the system of machinery that has been explained with all the matter, and some of the power which has been exerted in such undertakings, a degree of power may not be obtained which has never yet been tried in similar undertakings.

Let a building be raised, in a convenient situation upon the surface of the ground, place in it a steam engine whose power shall be one ton; connect this with an active wheel in the manner represented, in plate 2, *Fig.* 2 : let this weigh nine tons, its teeth be cut on the angle of eighty degrees, and its power will be eight tons :

M 2   connect

connect this with the passive wheel as at *Figs.* 9 and 10, plate 1, and let that raise or force the water from the greatest depth to which it can safely be carried; the power will, in this case be eight tons, and the effect such as that power is able to produce.

If it is desired to go to a greater depth, or to produce a greater effect than this quantity of power will produce, instead of making the passive wheel the raising or lifting power, connect its axis with a second active wheel which shall likewise, weigh nine tons, and add to this second active wheel a·passive wheel, as before, which is to become the lifting power; its effect will be as its own power multiplied by the power of that which acts upon it, or sixty-four tons: let this be repeated ten times and there will be eleven active wheels, each weighing nine tons, consequently ninety-nine tons in the whole; and as the power of each active wheel will be as its own power multiplied by the power which immediately precedes it, the power of the whole will

be

be seen by the following estimate, by which it will, likewise, appear that the same power may be continued to increase, progressively, in the same proportion to any extent to which it can possibly be required to apply it.

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64 \\
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512 \\
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4,096 \\
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262,144 \\
8 \\
\hline
2,097,152 \\
8 \\
\hline
16,777,216 \\
8 \\
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134,217,728 \\
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\hline
1,073,741,824 \\
8 \\
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8,589,934,592
\end{array}
$$
tons, being the moving

moving power of the whole. It has been already shewn, that the increase of velocity may accompany the increase of power, in any proportion that circumstances may render necessary, and it seems evident that this system of machinery may put a degree of mechanical power at our disposal, that has never yet been attained by any machinery whatever.

When it is considered that this power will be produced, by an original *extraneous* power of only one ton, it may be asked what effect would be produced, if such a train of machinery should be worked by the power of that steam engine which lifts, or raises one hundred tons of matter seventeen times in every minute that it is kept at work ? The firmest mind may feel a disposition to recoil on considering the conclusion to which the answer to this question must lead : yet, when it is considered that it follows, by fair induction, from experiments that have been made upon material objects, which exist, and may be produced to repeat those experiments which have been

been tried, or to try any others that may be
thought necessary to verify the facts, it is pre-
sumed that, however unwilling they may be to
receive implicitly the statements which have
been made, those who will be benefited by them,
if correct, will think them deserving of, and
therefore will take the trouble to give them the
most serious investigation.

THE END.

*** The Reader is requested to correct the following essential Errata,
Page 54 :—for two hundred and eighty-eight thousand ; *read* twenty-eight
thousand eight hundred.

1. *The second edition, price 5s. in boards..*

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———

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cessful or unsuccessful, are related with much perspicuity,
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ing a deformed offspring, it must be consoling to see their
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only relieved from weakness and disease, but restored to health,
vigour, and the natural beauty of the human figure, which
has such an influence on society. Nor can it be ungrateful to
the general philanthropist to learn, that in the course of a few
years,

years, not less than sixty-two persons have been cured by the exertions of our author. The particular nature of these diseases and cures is exhibited by the plates, in outlines, drawn from models taken from the different limbs, both before and after the cures. Mr. T. Sheldrake has obtained a patent for the instruments which he uses in restoring distorted feet and legs to the natural position. When we consider that medical men in general have thought these things unworthy their attention, that very little science has yet been exercised in the construction of trusses and instruments for improving crooked limbs, and that they are generally made by mere mechanics, who have no anatomical knowledge, we can discover no reason why an ingenious and regularly educated gentleman, who may have made some useful discoveries in this neglected department of medical science, should not meet with every encouragement which circumstances may admit, or the nature of the subject deserve. This, however, to the prejudice of the public as well as the author, has not been the case; and he complains, with much apparent justice, of the improper conduct of his near relation, and also of a nominal editor of a medical journal. With these *personal* matters it is not our province to interfere, and if it were we should not decide, in such a striking case, on *ex parte* evidence. We were rather surprised, indeed, to find that the author had been engaged in a controversy with one of his colleagues at the Westminster Hospital, a man of real talents, and formerly a very sanguine, now a very diffident practitioner, but still with a mind very superior to the other professor here alluded to. We acknowledge, however, both the justness and talents displayed in Mr. Sheldrake's remarks (p. 122-3) on that gentleman's letter. Upon the whole, we can only recommend this work to the attention of medical practitioners,